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Procedia CIRP 15 (2014) 367 – 372

www.elsevier.com/locate/procedia

21st CIRP Conference on Life Cycle Engineering

Toward a sustainable business design: a survey

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Abstract

Sustainable business is characterized by its facets to balance triple bottom lines (i.e., profit, planet, and people). In sustainable business design, it is crucial to consider interaction between the core business and external environment, which does not seem to influence the profit of the core business but necessary to explain their intended environmental and social value proposition. To construct a particular model of sustainable business, the paper conducted a survey on the study of business models and, in particular, sustainable business models (e.g., eco-innovations, sustainable innovations, product-service systems). The survey focuses on how the study models external environment and its influences on the core business characterized by "externality". Through discussion on the findings of the literature review, three key issues to be addressed for constructing sustainable business model are identified: taxonomy of externality, identification of a set of models (i.e., aspect model), and identification of interrelationship among them. First and second issues clarify particular aspects of externality. By considering third issue, the designer is able to design sustainable business by integrating these aspects.

Selection and peer-review under responsibility of the International Scientific Committee of the 21st CIRP Conference on Life Cycle Engineering in the person of the Conference Chair Prof. Terje K. Lien

Keywords: Sustainable business; business model; externality; aspect model

1. Introduction

Due to growing concern about sustainability of local or global environment, community, society, or economy, adequate design of product life cycle become increasingly important as well as the design of a product itself. Since Alting [1] proposed the life cycle engineering concept in 1993 to tackle this problem, many concepts, approaches, methods, and tools have been developed and discussed in the CIRP community. Example includes closed-loop-product life cycle [2], design of life cycle scenario [3], design of End-Of-Life (EOL) strategy [4], life cycle simulation [5], modular design [6], disassembly planning [7], and so forth.

However, even if the product life cycle is adequately designed taking into account the future opportunities for product (or component) reuse, material recycling, and energy saving, it would be useless without the business model which describes the roles and responsibilities of every stakeholder to comply with the designed product life cycle. Thus, the business model suitable to the designed product life cycle should also be designed simultaneously.

Since sustainable business can be seen as the business that have multiple facets to balance triple bottom lines (i.e., profit, planet, and people), it is natural to introduce environmental, social, and sometimes ethical aspects to a conventional business framework. In order to take them into account, it is crucial to broaden business scope to consider indirect cause effect chains outside of the firm that do not directly influence its profit. For example, carbon offset businesses, which provide primary products and services in addition with certificates of carbon dioxide reduction, which neutralizes the carbon dioxide emission associated with the products and services, cannot be established without using the external scheme of carbon emission trade and their monetization mechanism.

The specific behavior of sustainable business derived from such cause effect chains across internal and external business environment and observed by broadening the business scope is

Selection and peer-review under responsibility of the International Scientific Committee of the 21st CIRP Conference on Life Cycle Engineering in the person of the Conference Chair Prof. Terje K. Lien
doi:10.1016/j.procir.2014.06.094

referred to as "externality" in the paper. The authors argue in the paper that explicit consideration of this externality is essential for the success of sustainable businesses. A considerable number of researchers have tackled to reframe the concept of "externality" in sustainable business design, which is traditionally (in the field of economics) regarded as the cost or benefit that affects a party who did not choose to incur that cost or benefit [8]. Examples include Product service systems (PSS) [9]/industrial product service systems (IPSS) [10], industrial ecology [11], strategic corporate social responsibility (CSR), and so forth. PSS/IPSS encourage the business to co-operate with a variety of stakeholders to reduce the cost overwrapped among them. Industrial ecology aims to make full use of wastes of some industry as resources for others. Strategic CSR aims to obtaining competitive advantages through the creation of social values other than provision of mere utility value to the customers. The essence of these concepts are broadening business scope and taking external resource into account to make the business more sustainable.

Although these concepts are successful in highlighting the design constraints and evaluation criteria other than those of conventional businesses through the analysis of a variety of case studies, it is still difficult to deal with and to make good use of the externality in sustainable business design. One reason for that is the underlying core logic for dealing with externality has not been clearly described in terms of business models, which are to be used as a common basis for their design and implementation.

The objective of this study is to investigate key issues for supporting the design of sustainable business, especially focusing on how businesses deal with externality (e.g., stakeholder relationships outside of the business, social and environmental value other than mere utility value to the customers, and so forth) to meet multiple facets of sustainable value. To this end, the paper conducted a literature review in terms of business models and the externality in sustainable business design at first. Then the paper identifies relevant issues to be addressed through discussion on the review results.

2. Literature review

2.1. Scope and objective

This section briefly surveys related work about sustainable business design. Before surveying related work, the paper first summarizes related work about generic business models. The survey is intended to answer the following questions:

- How externality is dealt with in the context of sustainable business design research including closely related concepts such as PSS/IPSS, eco-innovation, and so forth?
- What are the relevant characteristics and underlying core logics of sustainable businesses?

To answer these questions, the authors collected recent journal papers and technical reports, and selected 34 papers [12-46] for detailed review. The papers and reports are first collected with Google Scholar [47] with queries "business model" AND sustainability". In parallel, the authors identified journals, which contain papers listed in the first few pages in the result of the query. The journals included, for instance, Journal of cleaner production, Ecological economics, Long range planning, and Annals of the CIRP. Some papers apparently outside of the focus of the papers (e.g., about business models specifically dedicated to software) were subjectively excluded. Furthermore, the scope of the review was limited to recent publications (from 2005 to date). References [16] and [42] provide reviews of related work published earlier.

2.2. Business models

Sustainable business model is a narrower concept (class) of (generic) business model. The paper briefly reviews related literature concerning the study of business models, and investigates how related literature deals with the externality discussed in Section 1.

Related work concerning the study of business models has investigated representations, and classifications of business models, and corresponding modeling disciplines [32-34, 37]. Researchers started these studies at the introduction of e-commerce business [37]. As the variety of the business models was so large, the focus of the study shifted from the observation of business in practice to the development of a taxonomy to classify business in practice. Although the taxonomy developed in related work is an extension of the definition of Timmers [46], there is still no common taxonomy among researchers [42].

In [37], business models are defined as logic of profit generation. The logic was defined in terms of revenue resources, pricing methodology, and cost structures. Furthermore, the study classified business models in terms of levels (foundation, proprietary, rules) and decision areas (how to create value, for whom, advantageous resource, market position, how to make money, time-scope-size ambitions).

In [32], business models are classified into role models and scale models. The role models classify themselves in terms of adjectives clarifying their characteristics (e.g., *franchising* model). The scale models classify themselves regarding the name of typical companies executing the business models (e.g., *McDonald*'s model, *South West Airline*'s model). In order to develop such classifications, the authors adopted an approach following the scientific discipline, which is similar to those conducted in the field of economy and biology. As the study did not introduce hypotheses related to the externality in business models, the study could not result in role models or scale models that explicitly deal with the externality.

In [33], business models are regarded as a set of activities. Design elements such as contents, structures, and governance, were introduced as the elements of activities. Furthermore, business models are identified in terms of design themes. In the paper, positive network externality characterizes one of the design themes called *lock-in*. The other design themes introduced in the paper were *novelty* (whether new type of contents, structure, governance is included), *complementarities* (combination of two activity systems), and

efficiency (activity transaction with low costs, e.g., standardization, outsourcing).

In [34], business models are regarded as a configuration of business elements to produce a value proposition. The study adopts the Resources, Competences, Organization, and Value (RCOV) framework for the description of a business model, in which a business model is defined in terms of business elements such as resource, competences, organization, and value proposition. The RCOV framework has been used to analyze the evolution of the business model of Arsenal FC. In [34], such business models are developed by following the static approach and the transformational approach. The static approach is referred to as a process to explicitly describe a business model, while the transformational approach as a process to explicitly describe the transformation of the business model. With the static approach, sustainable business models can be regarded as business models including specific representing patterns. With the transformational approach, sustainable business models are developed through specific transformation patterns (e.g., internalization of external decision variables). By adopting the approaches the study of sustainable business models is a process to hypothesize and verify these specific representing patterns and transformation patterns by observing businesses in practice.

2.3. Sustainable business related concepts

Related work the authors have selected with a focus on sustainability concept are roughly classified into two categories: (1) Eco-innovation/sustainable innovation and (2) PSS and service related concepts.

(1) Eco innovation/sustainable innovation

Innovation is often seen as an indispensable element toward sustainable development. Although there exist a lot of different definitions for eco-innovation (or sustainable innovation), it can be seen as any form of innovation process that may result in significant reduction in environmental impacts (whether intentional or not). The key characteristics of eco (or sustainable) innovation concept are its address on non-technological form of innovation and novelty.

OECD [40] addresses the business model innovation that maximizes the long term gain of all stakeholders, combining three different types of innovations: incremental, disruptive, and radical innovations. Through the analysis of 95 business cases, the literature identified eight eco-innovation models (i.e., green value added products, renewable energy based systems, efficiency optimization by ICT, functional sales, innovative financing, sustainable mobility systems, industrial symbiosis, and eco cities) focusing on the differences in value proposition, business operations, customer aspects, core value proposition, first order value creation, and second order value creation.

Carrillo-Hermosilla et al. [20] have proposed an analytical framework for a diversity of eco-innovation focusing on five dimensions (design, user, product, service, and governance). Through six detailed case analysis results, the literature concludes that the capacity of eco-innovation depends on the interplays of these dimensions and engagement of key stakeholders.

Boons et al. [12, 16] define a sustainable innovation as "innovation that improves sustainable performance, where such performance includes ecological, economic, and social criteria". Through the survey on business model in terms of sustainable innovation, they highlighted three aspects vital to sustainable innovation: (1) redefinition of the value as the one exchanged among the stakeholders, (2) value creation in the larger system of which the firm is part, both technically and socially, and (3) a sound balance of costs and rewards for all actors involved. Matos et al. also address the relationship among stakeholders in terms of each individual balance between cost and reward [13].

In the eco-innovation/sustainable innovation context, there are no explicit descriptions about externality. Externality is implicitly expressed in terms of alliance, stakeholder relationship, conflict among different stakeholders, regulations, governmental roles and so forth.

(2) PSS and service related concepts

Since PSS concept have widely spread among academia and industry, the authors selected recent papers relating to PSS concepts, which includes new typology of PSS [15], recent case studies [25,44], and engineering approach to design and implement PSS [19,21,26,27].

In [15], a new typology to describe product-service systems was proposed for the classification of different types of business models from the perspective of the functions of a product. The typology introduced three levels of the description of PSS, namely: demands, functional, and structural levels. PSS are classified by the correspondences of the descriptions in different levels. Such a classification is not sufficient for the identification of externality observed in business models, because externality is described in a structural level regardless of the relations between the descriptions in the other levels.

EU-Commission [44] analyzed eight successful PSS business models focusing on four parameters: key features of a business model, business rational, environmental case, possibilities and barriers, to derive two sets of guidelines for business leaders and policy makers, respectively, so that both of them can collaboratively make a transition to PSS based society. The results show that the successful company actually has a potential in the form of either product capacity or knowledge that could be captured by diverting into a service market or taking the responsibility of the process related to the product. Thus, the key success factors are capturing the potential, creation of new incentive, and risk management. The literature also highlighted the three PSS specific barriers in addition with five generic innovation barriers in relation with 16 principles to overcome them. Although the barriers highlighted in the literature include external properties such as inertia (e.g., customer readiness) and infrastructure building, the externality has never been explicitly dealt with.

Chou et al. has proposed a systematic framework to handle information flows in service design [19]. In this framework "feedback map" and "service flow modeling" are defined to help decision makers build appropriate service models. These

tools provide comprehensive information and guidance to fit service activities to sustainable development. This approach links economic value to environmental benefits by organizing the service models in social networks. It also improves cooperation across profit and non-profit sectors and different knowledge domains.

Ueda et al. [28] conducted a survey on various types of value concepts throughout European history such as natural value and absolute value. It proposed an engineering approach to value creation and decision-making in sustainable society. The addressed problems are social dilemmas, public goods, and network externalities, in which externality plays a crucial role in gaining a consumer's utility. The literature focused on the value in co-evolution environment where both actors and their environment evolve simultaneously by tightly influencing each other. As an approach to value creation in such environment, three classes of value creation models are proposed along with three classes of values: provided-, adaptive-, and co-creative value. It explicitly mentions about externality especially focusing on network externality and provides a fundamental framework to analyze or synthesize multiple values focusing on interactions among producer, customer, environment, and either product or service. However, the framework is too abstract and general to represent each particular type of external causal and logical structure that are observed in sustainable business design. Thus, more detailed and specific representation methods are still needed to be developed.

3. Discussion

3.1. Key findings of the literature review

Table 1 summarizes the descriptions of business models from a variety of aspects appeared in the literature mentioned in Section 2. The aspects clarify the differences among the study in literature regarding its generality or specific focuses on sustainability.

First, the study of business models (see subsection 2.2) did not provide the commonly accepted definition of business models among the research community. Nevertheless, it commonly presented some aspects, which capture fundamental building blocks of business models (e.g., a set of activities) and their configurations. Such aspects are particularly useful to systematically design the structure of business models.

Second, the study of business models with focus on sustainability (see subsection 2.3) provided the designers with more refined aspects emphasizing the characteristics of sustainable business models. For instance, *logic of profit generation* in the study of (conventional) business models is reframed to *the long term gain of all stakeholders* and *value creation in the larger system of which the firm is part* in the study of sustainable business models. Such refined descriptions encourage the designers to broaden their scope of business in terms of time and external environment (e.g., stakeholders outside of their firm).

The differences of the aspects among the studies also clarify those in how external environments of business models are treated in business model design.

As reviewed in subsection 2.2, in business model studies, the designers regard external environment as situations or conditions, which their core business models are placed in or comply with. In contrast, in the study of sustainable business models, external environment are regarded as elements of business models, which are not fully controllable but interact with their core business models. Such interaction becomes potentials (or opportunities) for their core business models to be served as parts of large social systems contributing to the sustainability of the members of social systems. Thus, governments and administrative institutions (e.g., OECD), which are typical elements of external environment, actively participate the development of sustainable business models by providing guidelines, legislations, tax, and financial scheme [40]. In short, sustainable business design problem which aims to make good use of externality is not a subclass of conventional business design problem. It captures different aspects of business design problem addressing the ways to deal with various types of externality.

The literature review also clarified that the related work of sustainable business models has not provided formal representations compatible with the aspects, which specify the characteristics of sustainable business models (such as the role of external environments in them). For instance, five dimensions introduced in [20] and eight eco-innovation models [40] are not suitable for representing the logical and causal structure of external environment.

3.2. Issues to be addressed for sustainable business design

Therefore, for achieving sustainable business design, following issues should be addressed;

1. Taxonomy of externality: Although a variety of externality is explicitly or implicitly described in the domains of business model and sustainable business,

Table 1. Highlighted aspects in the reviewed literature

Literature		Addressed aspect	No.
Business model	[37]	logic of profit generation	1
		description levels (foundation, proprietary, rules)	2
		decision areas (how to create value, for whom, advantageous resource, market position, how to make money, time-scope-size ambitions)	3
	[33]	a set of activities	4
	[34]	a configuration of business elements to produce a value proposition (RCOV)	5
Sustainability related concept	[40]	the long term gain of all stakeholders	6
		policy role	7
	[20]	the interplays of five dimensions (i.e., design, user, product, service, and governance) and engagement of key stakeholders	8
	[12,16]	redefinition of the value as the one exchanged among the stakeholders	9
		value creation in the larger system of which the firm is part	10
		a sound balance of costs and rewards for all actors involved	11
	[13]	the relationship among stakeholders in terms of each individual balance between cost and reward	12
	[15]	three levels of the description of PSS, namely: demands, functional, and structural levels	13
	[19]	link between economic value and environmental benefits thorough organization of the service models in social networks	14
	[28]	the value in co-evolution environment where both actors and their environment evolve simultaneously by tightly influencing each other	15

it doesn't necessarily cover all possible classes of externality. Taxonomy of externality should be established to enable comprehensive and systematic consideration of externality. More extensive survey including economical, social, and environmental phenomenon (e.g., rebound effect [48], lock-in [33]) in addition with the case analysis of sustainable business will be promising to this end.

2. Identification of a set of aspect model for externality: There exist a variety of externality as discussed in section 2 and it is difficult to represent all kinds of externality within a single holistic model. It is natural to introduce a set of aspects considering such externality. Aspect model is defined as the model focuses on particular aspects of externality by using particular theories and methods. Logic of profit generation [37] and set of activities [33] which are described in subsection 2.2 can be seen as examples of aspect models. Identification of a sufficient set of aspect models which can cover all classes of externality is important for supporting sustainable business design in a systematic manner. To identify sufficient set of aspect models, it is quite helpful to map them focusing on two dimensions: *misfit between representations of internal and external systems*, and *interdependency between internal and external systems*, which will be explained in subsection 3.3.
3. Identification of interrelationship among aspect models to enable their integrated utilization: A comprehensive consideration of every types of externality is the key to find out successful sustainable business model. Thus, integrated utilization of these models is critical to design sustainable business, because each model can only represent each particular aspect of externality. The way for correlating each aspect model with others through adequate interpretation of parameters and logical structure of different ones is indispensable for sustainable business design. System of Systems (SOS) [49] and 1DCAE concepts [50], both of which aim at finding the method and theory for effective and efficient utilization of multiple models across different disciplines can be applicable to this end.

3.3. Four classes of aspect models

The representation model for externality can be classified into four classes focusing on two dimensions as follows;

- *Misfit between representations of internal and external systems*: Here, misfit means, for instance, the degree of the detail of logical and causal structure of external system relative to that of internal system.
- *Interdependency between internal and external systems*: the degrees of influences of the external system on the logical and causal structure of internal system, and vice versa.

Fig. 1 depicts four classes of aspect models regarding these dimensions. Most aspects used in business models in literature belong to region III in Fig. 1, where the external system is represented by the same model as that of internal system (i.e., core business model) without considering the interdependency between internal and external systems. In the aspects belonging to region III, external systems constrains corresponding internal systems. However, these aspects alone cannot represent externality characterizing sustainable business. For instance, selling of energy saving products such as hybrid vehicles with better mileage might be regarded as sustainable business when it is evaluated by the aspect model focusing on fuel consumption of the vehicle, which is located in region III. However, the sales of the products doesn't always yield any environmental benefits due to "rebound effect." The diffusion of energy efficient vehicle increases the usage of vehicles, which eventually increases energy consumption as a whole. Thus, both rebound effect and energy efficiency of the vehicle should be considered in designing sustainable business. An aspect representing rebound effect (i.e., customer behavior) can belong to region I, because any internal business logics might exclude rebound effect (i.e., misfit between internal and external representations) and the customer behavior should be controlled by certain incentive scheme (i.e., interdependency between internal and external logics).

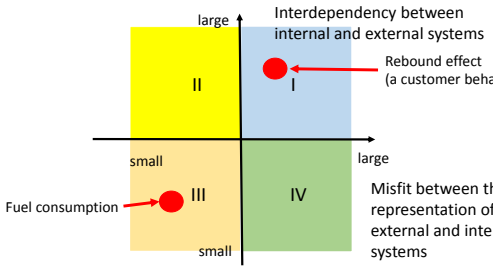

Fig. 1. Four classes of aspect models

4. Summary

To investigate key issues for supporting sustainable business design, the paper conducted a literature review focusing on externality in the domains of business model and sustainable business related studies. Discussing about the key findings of the literature review, three key issues to be addressed for constructing sustainable business model are identified as follows: taxonomy of externality, identification of a set of aspect models each of which represents a particular aspect of externality, and identification of interrelationship among them so that business can comprehensively consider various types of externality through integrated utilization of multiple aspect models.

Acknowledgements

This research is partially financially supported by Grant-in-Aid for Scientific Research (No.24603039), JSPS, Japan. The authors also acknowledge the useful discussion of this work

with Dr. Shinichi Nakamura, Prof. Toshitake Tateno, Dr. Mitsutaka Matsumoto, and Prof. Yutaka Nomaguchi.

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